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Opisthoteuthis calypso (Cephalopoda: Octopoda) collected on bathyal bottoms of the northern Tyrrhenian Sea (western Mediterranean)

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Abstract

The presence of the deep-sea cirrate octopod *Opisthoteuthis calypso* Villanueva, Collins, Sánchez & Voss, 2002, a recently described species, is reported for the northern Tyrrhenian Sea (western Mediterranean). The catch was obtained during an experimental haul, on a muddy bottom at 710 m of depth. Morphometric and meristic parameters of the four specimens caught, two males and two females, fully agree with the diagnostic characters of the species. The two males (DML 33 and 54 mm respectively) were sexually mature, with several spermatophores in the seminal vesicle; the two females (DML 29 and 30 mm respectively) were in maturation, without any oocytes in the distal oviduct and in the oviducal gland. The ovarian oocyte size distributions confirm for this species a continuous-spawning reproductive pattern, in contrast to the semelparity shown by the majority of incirrate octopods; the stomach contents analysis highlights that predation, based on hyperbenthic crustacean prey, mainly occurs near the bottom.

Riassunto

Viene segnalata la presenza nel Mar Tirreno Settentrionale (Mediterraneo occidentale) del cefalopode ottopode cirrato *Opisthoteuthis calypso* Villanueva, Collins, Sánchez & Voss, 2002, una specie recentemente descritta come nuova per questo genere. Sono stati catturati quattro esemplari, due maschi e due femmine, in una cala effettuata su un fondo fangoso di 710 m, nel corso di una campagna di pesca a strascico sperimentale. I dati morfometrici e meristici rilevati su ciascun esemplare sono pienamente in linea con i caratteri diagnostici della specie. I due maschi (LDM 33 e 54 mm) erano sessualmente maturi, con alcune decine di spermatofore nelle vesciche seminali. Le due femmine (LDM 29 e 30 mm) erano invece in maturazione, senza ovociti nell'ovidotto distale, né nella ghiandola oviducale. La distribuzione delle taglie degli ovociti contenuti negli ovari delle due femmine conferma una modalità di deposizione di tipo continuo, contrariamente alla semelparità, modalità tipica di quasi tutti gli ottopodi incirrati. I contenuti stomacali hanno rivelato la presenza di crostacei soprabentonici, confermando che la predazione da parte di questa specie avviene per lo più in prossimità del fondo.

Key words

Cephalopoda, Opisthoteuthidae, Tyrrhenian Sea, western Mediterranean.

Introduction

The species of the genus *Opisthoteuthis* (Cephalopoda: Octopoda: Opisthoteuthidae) show some distinctive characteristics among the cephalopods, such as the oval body compressed along the longitudinal axis, the gelatinous consistence and the large interbrachial web, so that they are popularly called "flapjack" or "pancake devil fish" (Norman, 2000).

Opisthoteuthis species are cirrate octopods (suborder Cirrina Grimpe, 1916) (cf. Sweeney & Roper, 1998), characterised by the presence of cirri on the ventral side of the arms. Other distinctive features of this genus are two small fins on the mantle, an internal U-shaped shell with a groove in its outer surface, suckers of different size in the arms of males, placed in two enlargement fields and, in most species, one or more muscular nodules (web supports) located on the ventral margin of the arms (Villanueva et al., 2002).

These species, as the other cirrate octopods, live typically in deep water habitats, but the *Opisthoteuthis* species seem to have a shallower distribution (mostly the in bathyal zone) and are more closely associated to the bottom, being anyhow capable of swimming in the water column.

Due to their delicate and gelatinous consistency, in many cases the *Opisthoteuthis* specimens collected by bottom trawling are in poor conditions so that it is impossible to easily detect the species diagnostic characters.

After the revision of the systematics and biology of the genus *Opisthoteuthis* (Villanueva et al., 2002) from the Atlantic waters, with the description of two new species (*O. calypso* Villanueva, Collins, Sánchez & Voss, 2002 and *O. hardy* Villanueva, Collins, Sánchez & Voss, 2002), to date five species are known to belong to this genus in the Atlantic-Mediterranean region: *O. agassizi* Verrill, 1883, *O. grimaldii* Joubin, 1903, *O. massyae* (Grimpe, 1920), *O. calypso*, and *O. hardy*.

Villanueva et al. (2002) described *O. calypso* as a new species, after a re-examination of specimens coming from the eastern Atlantic and previously identified as *O. agassizi*. At the same time they assigned to *O. calypso* the Mediterranean specimens previously ascribed to *O. agassizi*, so that *O. calypso* is up to now the only *Opisthoteuthis* species known to occur in this area. These two species have different geographical distributions. *Opisthoteuthis*

calypso has been recorded in the eastern Atlantic, from Ireland to South Africa, and in the western Mediterranean; *O. agassizi* is present in the northwestern Atlantic, mainly in the Gulf of Mexico and the Caribbean region. The main characters differentiating *O. calypso* from *O. agassizi* are the occurrence in the former species of a single muscular nodule (web support) in all the arms, instead of the multiple web supports of *O. agassizi*. In addition, the two species can be distinguished from each other by the total number of suckers in each arm (47-58 in *O. calypso*, 58-80 in *O. agassizi*) and by the different arrangement of the enlarged suckers in the arms of males. The proximal enlargement field affects the suckers from 4 to 11 in *O. calypso*, those from 5 to 13 in *O. agassizi*; the distal field ranges from sucker 24 to sucker 29 in the former species, from 23 to 44 in the latter. Moreover, particularly large suckers in the proximal enlargement field are present on the third pair of arms of *O. calypso*, on the first and fourth pairs in *O. agassizi*.

Though several biological and ecological aspects of Atlantic *O. calypso* have been investigated, such as the reproductive biology (Villanueva, 1992a) and feeding (Villanueva & Guerra, 1991), still little information is available from the Mediterranean, because only a few specimens have been collected in the western sector of the basin (Morales, 1959, 1962; Villanueva 1992b; Quetglas et al., 2000; Orsi Relini et al., 2001; Cuccu et al., 2006).

The purpose of this work is to provide information on the morphometry of four specimens of *O. calypso* collected on bathyal bottoms of the northern Tyrrhenian Sea, during an experimental trawl survey, in the year 2000, in order to increase the knowledge on this rarely caught Mediterranean species.

Material and methods

Four specimens of *Opistlioteutliis calypso* were collected on the 28 September 2000, during an experimental trawl survey, carried out in the northern Tyrrhenian Sea. The catch was obtained in a daytime one-hour haul, on muddy bottoms of the bathyal zone to the East of the island

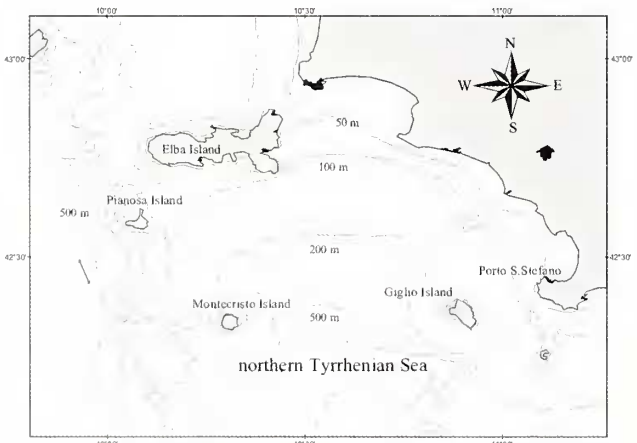

Fig. 1. Geographical location of the haul (black line) where *Opisthoteuthis calypso* was caught.

Fig. 1. Posizione geografica della cala (linea nera) ove è stata catturata *Opisthoteuthis calypso*.

Fig. 2. Left: Oral view of the 54 mm DML male; right: aboral view of the 33 mm DML male. Scale bar = 5 cm.

Fig. 2. Sinistra: lato orale del maschio di 54 mm LDM; destra: lato aborale del maschio di 33 mm LDM. Scala = 5 cm.

of Pianosa (geographical position: 9°57.03' – 9°55.92' W; 42°26.31' – 42°29.11' N; average depth 710 m) (**Fig. 1**). They were sampled by a commercial trawl net routinely used on local fishing grounds, with a 40 mm cod-end mesh size (stretched). The trawl was carried out by a commercial otter trawler (89 gross registered tonnage, 22.5 m overall length, 800 hp engine) based in the harbour of Porto Santo Stefano. For further specifications of the sampling protocol and the sampling gear see De Ranieri (2003). The animals were measured on board soon after their capture: dorsal mantle length (DML) to 1 mm; total weight (TW) to 0.1 g. Afterwards, they were fixed in 10% neutralized formalin and then preserved in 70% ethanol for further analyses.

A macroscopic analysis of each specimen was carried out, with particular attention to the morphology of the arms and the size of suckers. Sex and maturity stage of the gonads were recorded in each individual, according to the presence or absence of spermatophores in the seminal vesicle and penis in males, and of oocytes in the oviducal gland and distal oviduct in females. Ovaric oocytes were measured (to 0.1 mm) by a dissecting microscope with an ocular micrometer.

Results

The four specimens were in rather good conditions when collected, without any evident damages (**Fig. 2**); only the distal part of some arms was either broken or lacked suckers. The body was gelatinous, flattened, oval shaped and displayed two small fins; the arms bore one row of suckers and two rows of cirri, a distinctive character for the cirrate octopods. A large interbrachial web enveloped the arms throughout their length, except for their distal ends; the occurrence of an internal U-shaped shell was detected (**Fig. 3**). The body was uniformly reddish-brown coloured.

The mantle cavity analysis showed that the four specimens were two mature males (33 and 54 mm ML, 64.8 and 162 g TW, respectively) and two maturing females (29 and 30 mm ML, 50.6 and 48.2 g TW, respectively).

The individuals showed all the diagnostic characters re-

Fig. 3. Dorsal view of the shell of the 54 mm DML male. Scale bar = 10 mm.

Fig. 3. Vista dorsale della conchiglia del maschio di 54 mm LDM. Scala = 10 mm.

ported by Villanueva et al. (2002) for *O. calypso*; each arm had a single muscular nodule and the typical number of suckers. The two males clearly showed the distinctive arrangement of suckers of *O. calypso* (**Tab. 1**); the first

arm	side	enlarged proximal field	suckers distal field	suckers
DML 54 mm				
I	right	4-7	23-25	49
	left	4-7	24-25	48
II	right	4-8	24-25	50
	left	4-8	24-26	*
III	right	4-8	23-25	48
	left	5-9	25	50
IV	right	5-9	23-26	*
	left	5-10	24-26	52
DML 33 mm				
I	right	5-8	23-25	46
	left	5-8	24-25	47
II	right	5-8	23-26	48
	left	4-8	24-27	47
III	right	4-9	25	48
	left	5-9	25-26	49
IV	right	5-8	**	
	left	4-8	**	

Tab. 1. Position of the enlarged suckers and number of suckers for each arm of the two males of *Opisthoteuthis calypso*.

Tab. 1. Posizione delle ventose ingrandite e numero delle ventose di ciascun braccio dei due maschi di *Opisthoteuthis calypso*

Fig. 4. Spermatophores found in the seminal vesicle of the 54 mm DML mature male. Scale bar = 3 mm.

Fig. 4. Spermatofore trovate nella vescicola seminale del maschio maturo di 54 mm LDM. Scala = 3 mm.

enlargement field consisted of 3-6 large suckers, started at suckers 4-5 and ended at suckers 9-10; the second enlargement field consisted of 1-4 large suckers, started at suckers 23-25 and ended at suckers 25-27. In both males, the sucker enlargement of the proximal field was greater on the arms III. The total number of arm suckers ranged from 47 to 52 in the males, from 45 to 49 in the females.

The analysis of the male genitals revealed the presence of oval shaped spermatophores, 1-2 mm in maximum diameter (**Fig. 4**), in the seminal vesicle: 40 spermatophores in the larger male, 27 in the smaller one.

Many oocytes of very different sizes and at different development stages were found in the ovary of the two females (**Fig. 5 A**). They were arranged in short strings, with the largest oocytes placed at the tip of each string. No oocytes were found in the distal oviduct and in the oviducal gland of both females. There were 221 oocytes (size range: 0.1-5 mm) in the 29 mm DML female, 272 (size range: 0.1-5.6 mm) in the 30 mm DML one. The oocytes were spherical up to the size of 1 mm, oval at larger sizes; their surface was smooth up to 2 mm and then became progressively reticulated; folds were evident in oocytes larger than 3 mm (**Fig. 5 B**).

Most oocytes were smaller than 2 mm and accounted for 85% of the total oocytes in the 30 mm DML female, for 73% in the 29 mm DML one. From the size of 2 mm on, an average of 1-3 oocytes per size class were found in each female (**Fig. 6**).

Some stomach contents were present in three specimen, consisting of remains of amphipods (at least three spec-

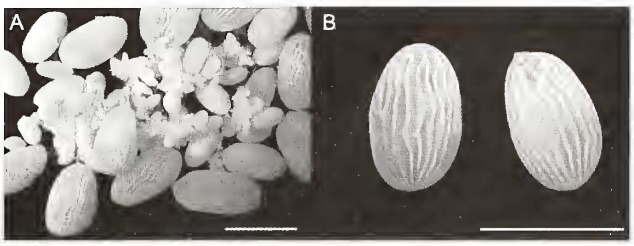

Fig. 5. A. Oocytes of the 30 mm DML maturing female. **B**. Detail of two reticulated oocytes of the 30 mm DML maturing female. Scale bar = 5 mm.

Fig. 5. A. Oociti della femmina in maturazione di 30 mm **B** LDM. Dettaglio di due oociti reticolati della femmina in maturazione di 30 mm LDM. Scala = 5 mm.

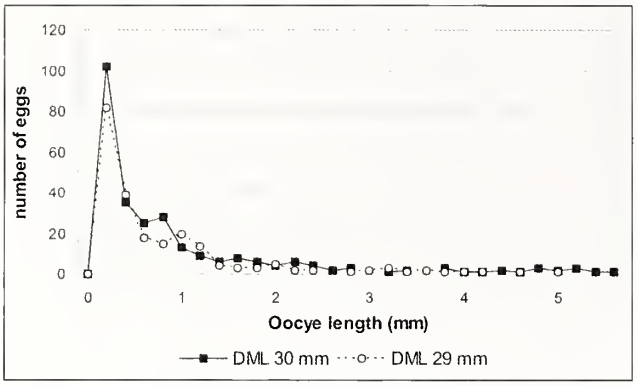

Fig. 6. Size frequency distribution of the oocytes of the two females (size class width = 0.2 mm).

Fig. 6. Distribuzione di frequenza di taglia degli oociti delle due femmine (ampiezza delle classi dimensionali = 0,2 mm).

imens), one mysid, one polychaete, and one copepod, in all.

Discussion

Opisthoteuthis calypso is a species new to the teuthofauna of the northern Tyrrhenian Sea, to be added to the 31 species up to now recorded from this area (Belcari & Sartor, 1993; Sanchez et al., 1998). As for the Italian waters, this species was previously reported from the Ligurian Sea by Orsi Relini et al. (2001), as *O. agassizii*, and from the Sardinian seas by Cuccu et al. (2006). According to Villanueva et al. (2002) *O. calypso*, occurs in a wide area of the eastern Atlantic Ocean and has also been recorded in other western Mediterranean areas, i.e. the Catalan Sea (Morales, 1959, 1962; Villanueva, 1992b) and the Balearic Sea (Quetglas et al., 2000), and has been collected from a wide depth range, 365 to 2,287 m. The species seems to be rather abundant on the bathyal bottoms of the south-eastern Atlantic. The findings reported from this area are frequent also for the upper limit of its bathymetric range (400 to 600 m). Catches proceed from both experimental surveys and commercial fishery, being *O. calypso* not infrequently discarded, as a by-catch, by trawlers targeting large gadiform fish (Villanueva & Guerra, 1991; Roeleveld et al., 1992).

On the other hand, the records of *O. calypso* from the Mediterranean are still occasional and all proceed from experimental surveys; in addition, most catches come from trawls on bottoms deeper than 700 m, which are still poorly investigated. As a matter of fact, a substantial sampling effort was performed in the last two decades in a wide Mediterranean area on soft bottoms down to 800 m, within both the international MEDITS and the Italian GRUND trawl surveys (Relini, 1988; Bertrand et al., 2002), whereas the only information for deeper bottoms comes from investigations quite limited in time and space.

These considerations could lead to the supposition that in the Mediterranean *O. calypso* is more abundant in waters deeper than its usual depth range, where the environmental conditions are rather stable and probably more similar to those of its Atlantic habitat. Indeed, *O. calypso* seems to be particularly adapted to the deep-sea environment, a characteristic in common with the other cirrate octopods, found down to 7,229 m depth (Voss, 1988).

The morphometric and meristic characteristics of the four specimens of *O. calypso* described in this study fully agree with the diagnostic features reported in the new species original description by Villanueva et al. (2002). The muscular nodule in the arms was rather apparent in all the specimens, providing a good diagnostic character for the species identification. The position of the enlarged suckers on the arms of males and the counts of suckers fit the lower limits of the diagnostic ranges for *O. calypso* provided by Villanueva et al. (2002). This could be due to the size of our specimens, ranging from 29 to 54 mm DML and from 48 to 176 g of TW, that is small to medium size. Indeed, *O. calypso* can reach considerable sizes: Villanueva & Guerra (1991) reported DMLs from 13 to 108 mm and TWs from 4 to 5400 g for specimens caught in Namibian waters.

The presence of several spermatophores and the evident enlargement of suckers in all the arms unambiguously indicated that the two males were sexually mature, even though the smaller one was lighter (65 g TW) than the minimum maturity weight (95 g) reported by Villanueva (1992a).

As for the females, both specimens were in maturation, according to the absence of oocytes in the terminal part of the oviduct and in the oviducal gland. They were considerably lighter (48 and 51 g TW) than the minimum female maturity weight (190 g) (Villanueva, 1992a); also the maximum observed oocyte size (5.6 mm) was smaller than that reported for mature females (7.5 mm) (Villanueva, 1992a). The analysis of the ovarian oocytes size frequency confirms the continuous-spawning reproductive strategy for this species, as described by Villanueva (1992a) for mature individuals of *O. calypso* collected all year round in the Namibian waters: the egg production is continuous throughout the mature life span, eggs are released one or two at one time and a considerable body growth takes place from the onset of sexual maturity on. This is the typical reproductive strategy of the genus *Opisthoteuthis* as well as of all cirrate octopods (Daly et al., 1998). On the contrary, for many incirrate octopods the semelparous reproductive strategy is well known; females show a limited growth when mature, produce just a single mass of eggs and die afterwards (Mangold, 1987; Rocha et al., 2001). Probably the continuous spawning is a fitting strategy in the stable deep-sea environment.

The stomach contents analysis confirmed a diet based mainly on suprabenthic crustaceans, as previously reported for *O. calypso* from Namibian waters (Villanueva & Guerra, 1991). The terms suprabenthos or hyperbenthos is referred to the association of small animals living in the water layer close to sea bed, mainly crustacean amphipods, decapods, mysids and cumaceans. These organisms are a basic food resource for juveniles of many demersal species and play an important role in the en-

ergy transfer in the demersal food chains (Mees et al., 1997).

As previously supposed, this species is probably not very rare in the Mediterranean waters; in order to increase its catches, a greater sampling effort on bathyal bottoms is needed.

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